Terrestrial Ground Penetrating Radar Studies as a Means of Constraining Lunar Near-Surface Properties

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Why use GPR?

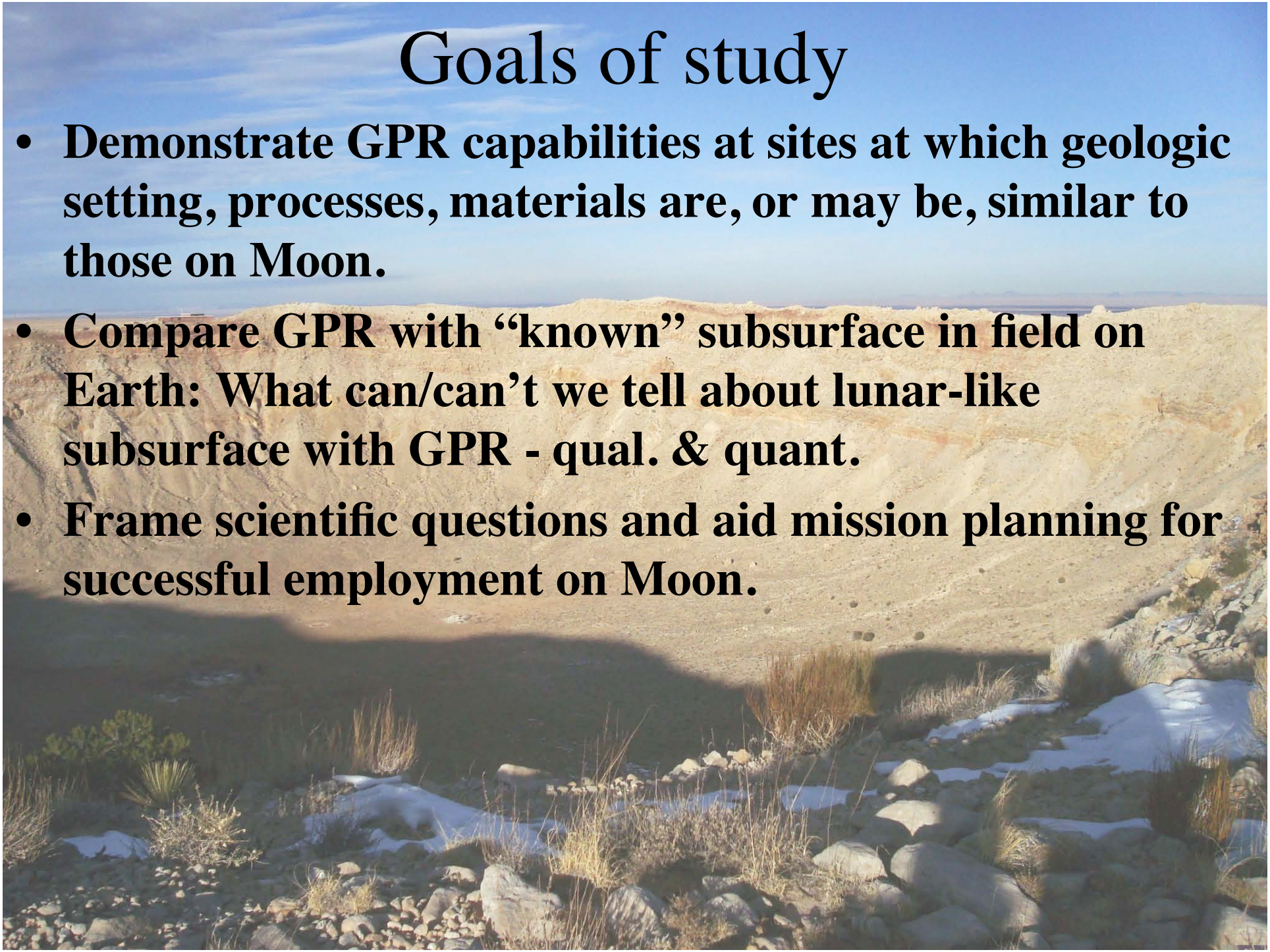
- Vertical, subsurface dimension is key to understanding local geologic processes over time.
- Location and physical properties of subsurface materials important for engineering.
- Complementary to drilling.
  - GPR: spatial coverage, deployment & use
  - Drill: materials analysis

What can we see?

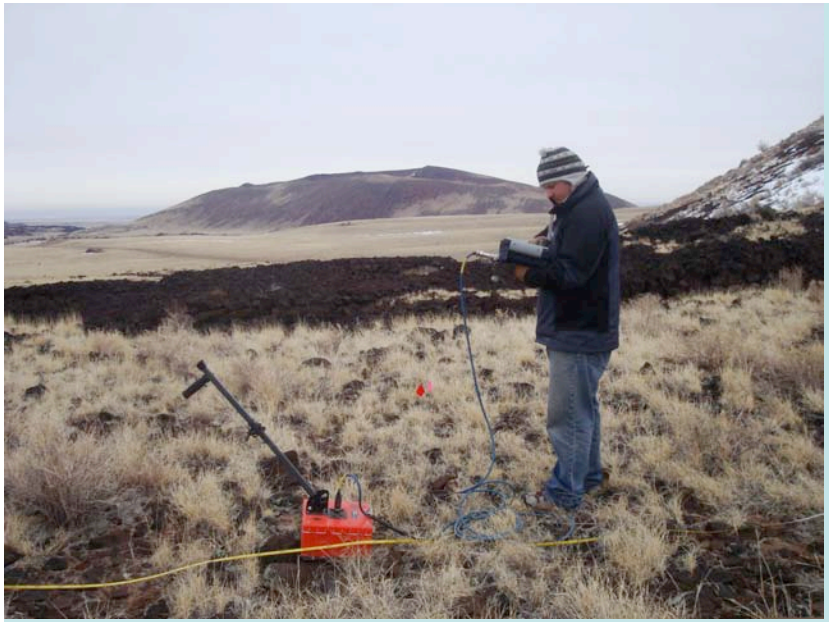
- Reflection off boundaries of differing dielectric properties (speed of waves in medium).
- Dielectric constant, density, degradation / weathering / fracturing, moisture, clay.
- 100 - 500 MHz to 0.5 m - ~8 m depth on Earth, same or more on Moon.
- Planar interface: Layering - eg lava flows, cinders, ejecta.
- Point reflector: Blocks / clasts - eg ejecta, fractured rock/basement.
- Voids - eg lava tubes

Goals of study

- **Demonstrate GPR capabilities at sites at which geologic setting, processes, materials are, or may be, similar to those on Moon.**
- **Compare GPR with "known" subsurface in field on Earth: What can/can't we tell about lunar-like subsurface with GPR - qual. & quant.**
- **Frame scientific questions and aid mission planning for successful employment on Moon.**

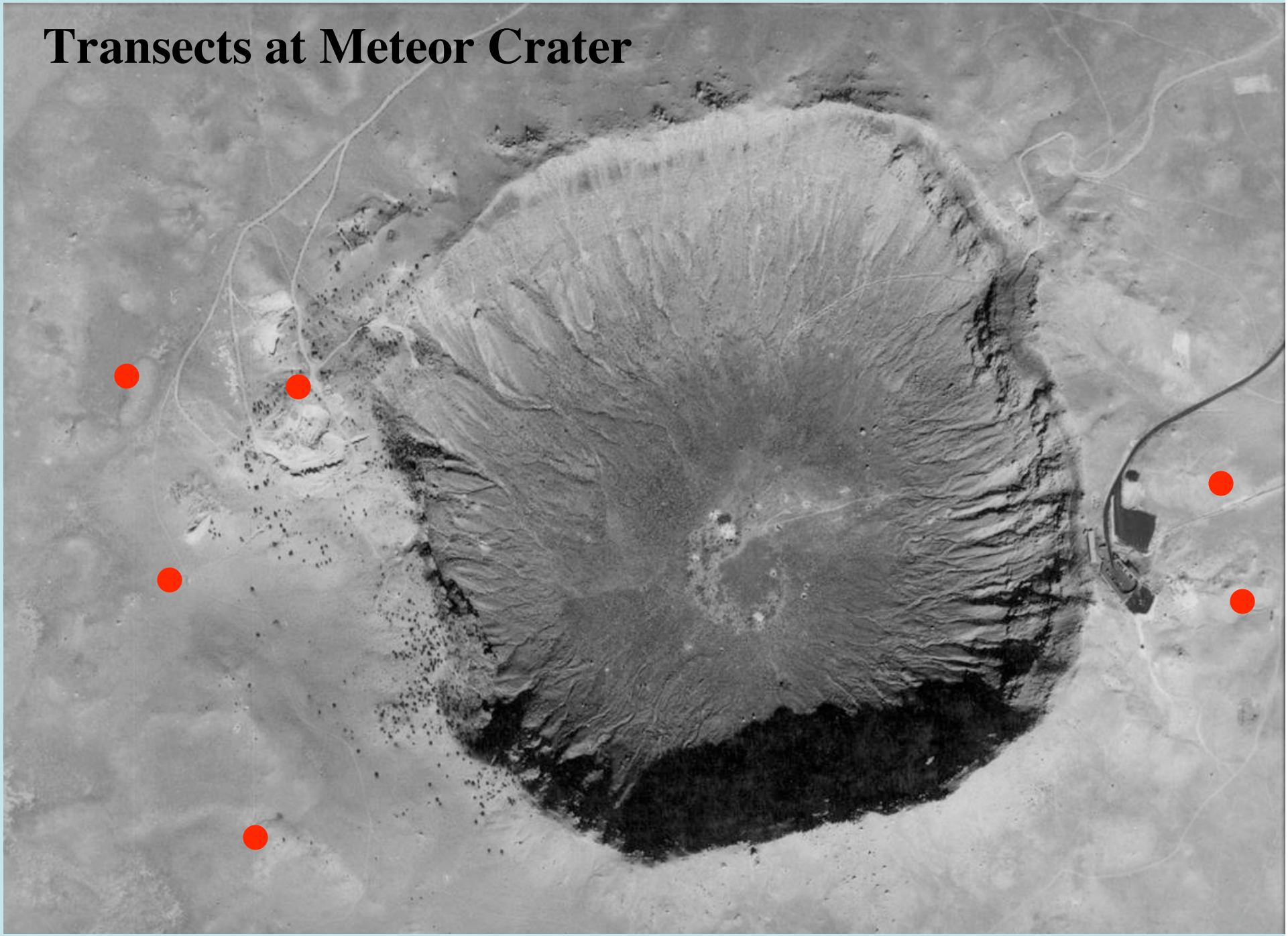


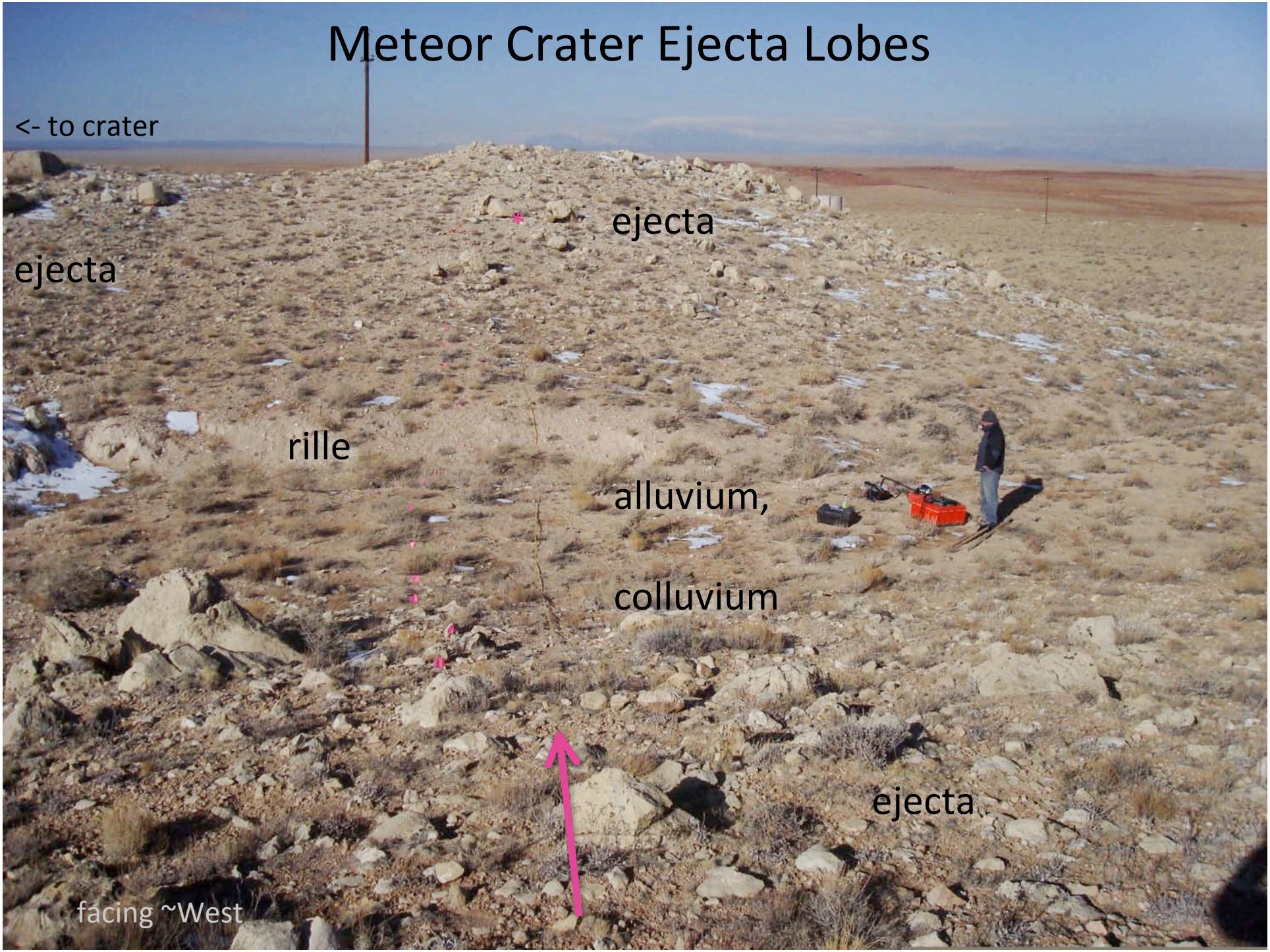
Field work



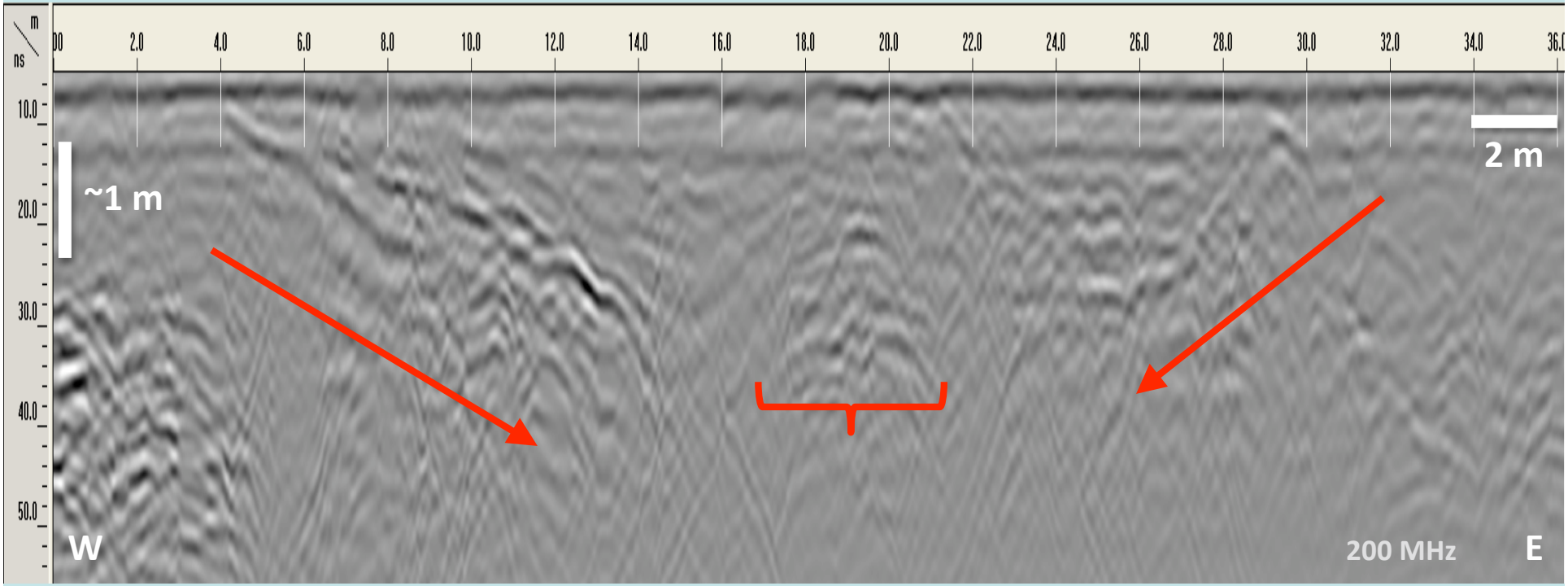
- 200 MHz & 400 MHz transceivers.
  - GSSI, not prototype - focus on science
- Barringer Meteor Crater: Block-size distribution in ejecta.
- SP cone & lava flow: Layering in cinders and emergence of lava flow at base of cone.
- (Sunset Crater: Cinder-lava contact and layering.)

Transects at Meteor Crater




Meteor Crater Ejecta Lobes
<- to crater
ejecta
ejecta
rille
alluvium,
colluvium
ejecta
facing ~West

Meteor Crater Ejecta Lobes

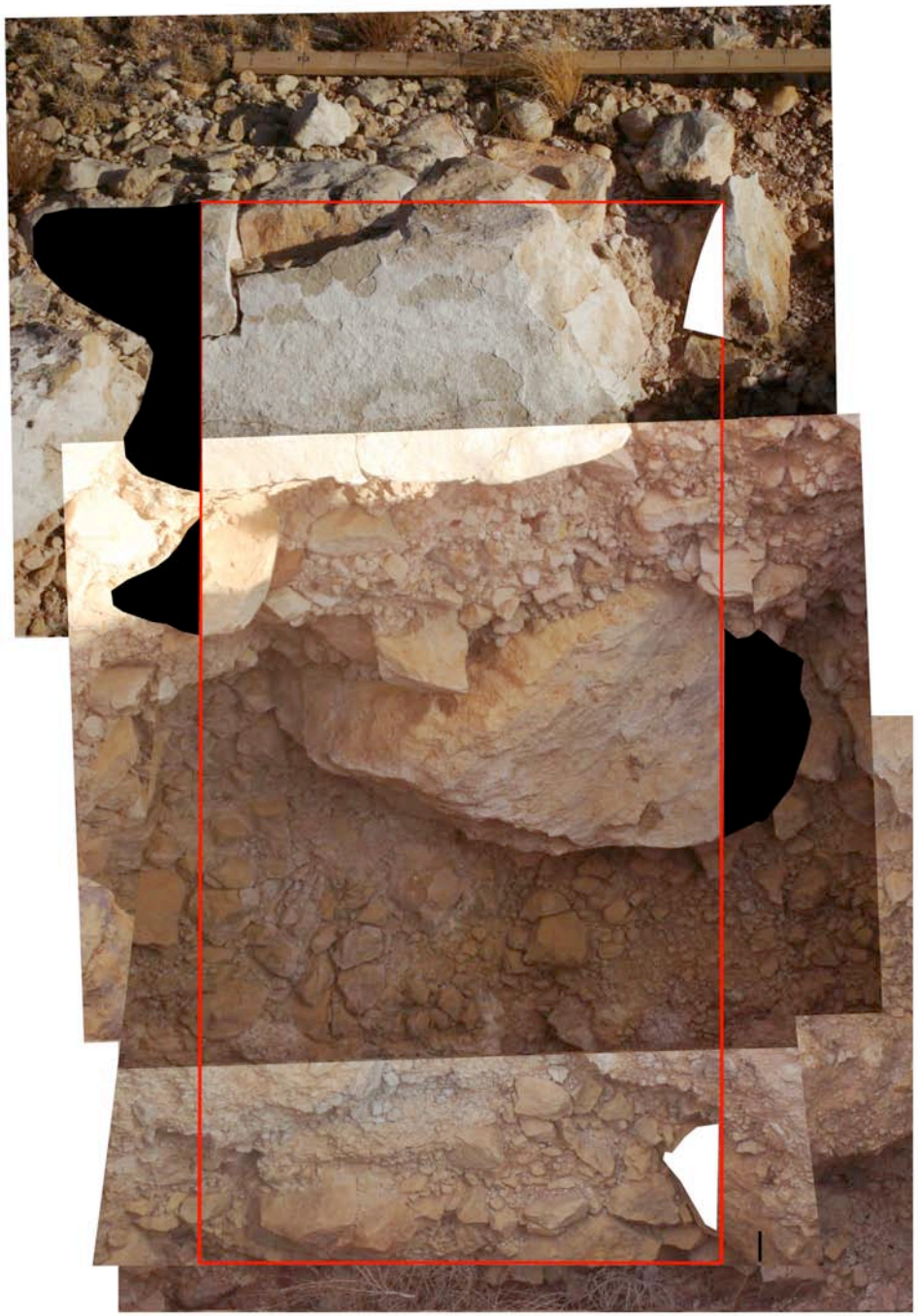


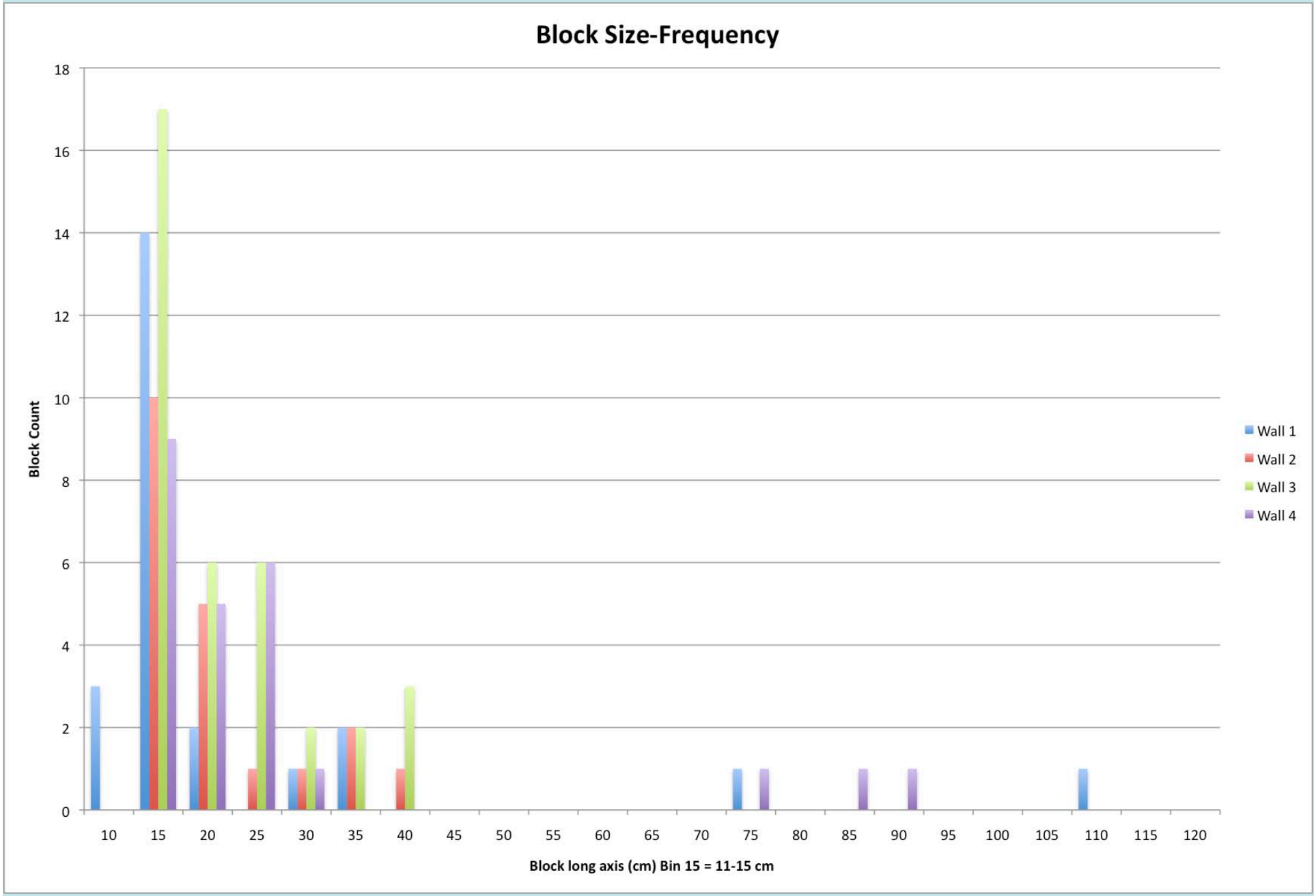
ejecta surface dipping under co/alluvium

subsurface reflector rising relative to rille surface

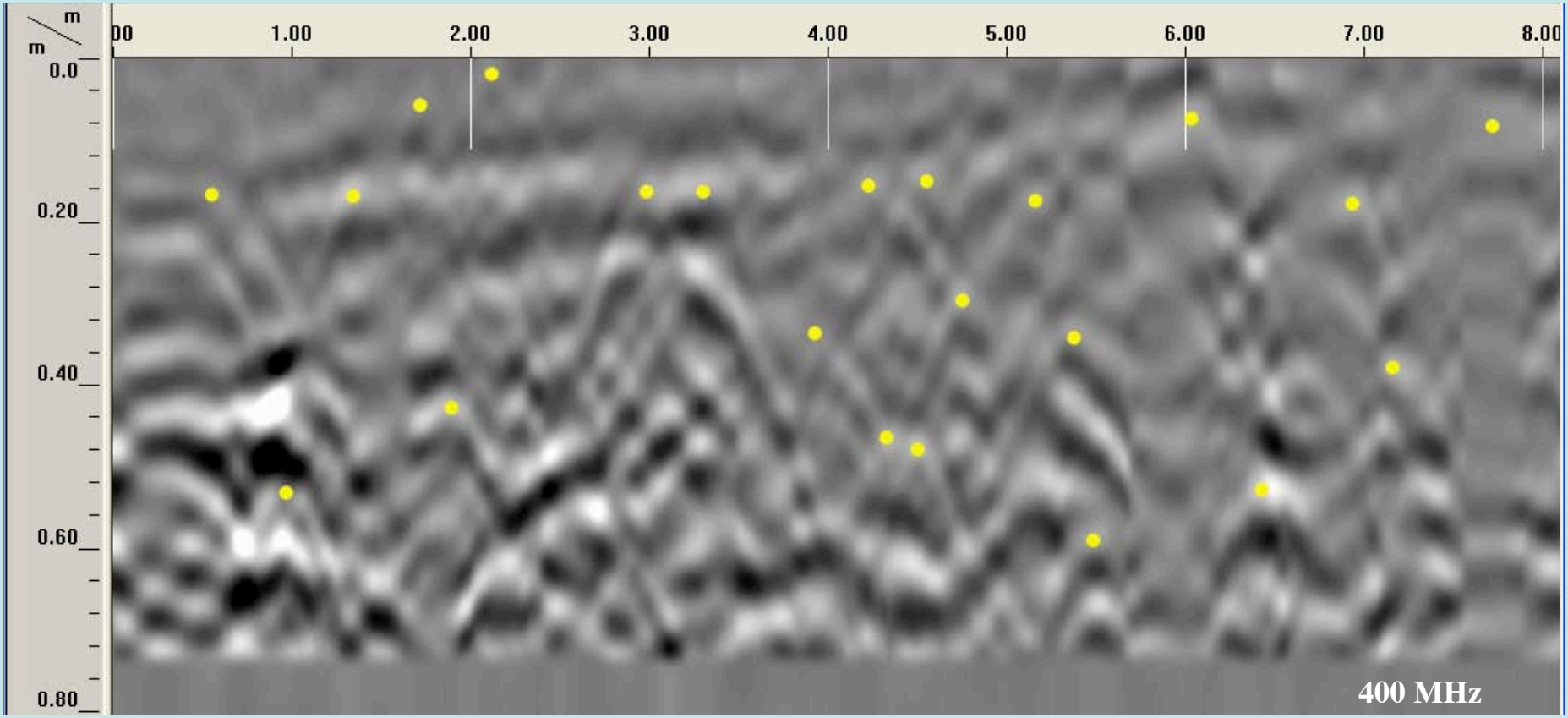
ejecta surface dipping under co/alluvium

Meteor Crater Ejecta Blocks



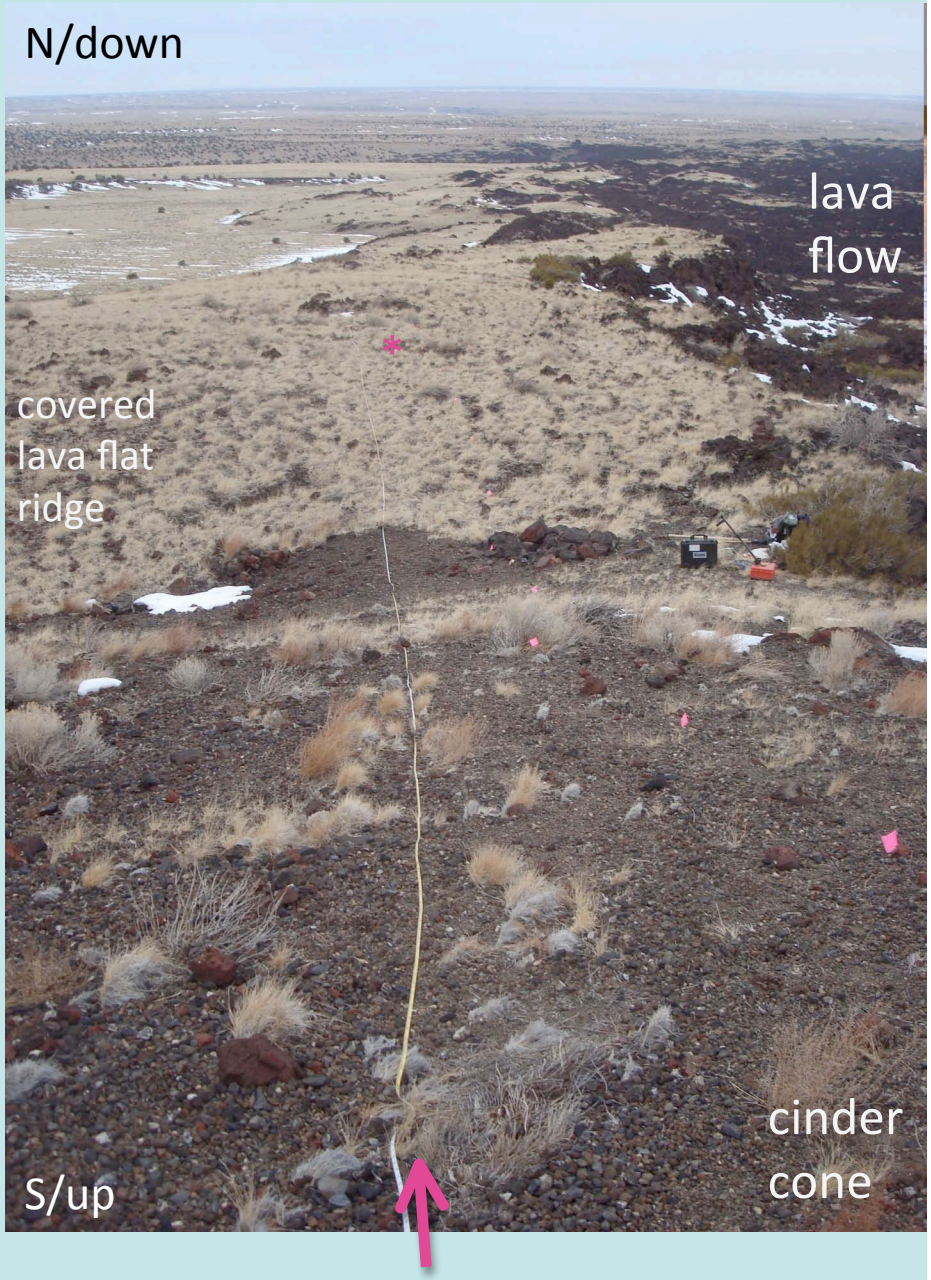

Block Size-Frequency
Block Count
0
2
4
6
8
10
12
14
16
18
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100
105
110
115
120
Block long axis (cm) Bin 15 = 11-15 cm
Wall 1
Wall 2
Wall 3
Wall 4

GPR

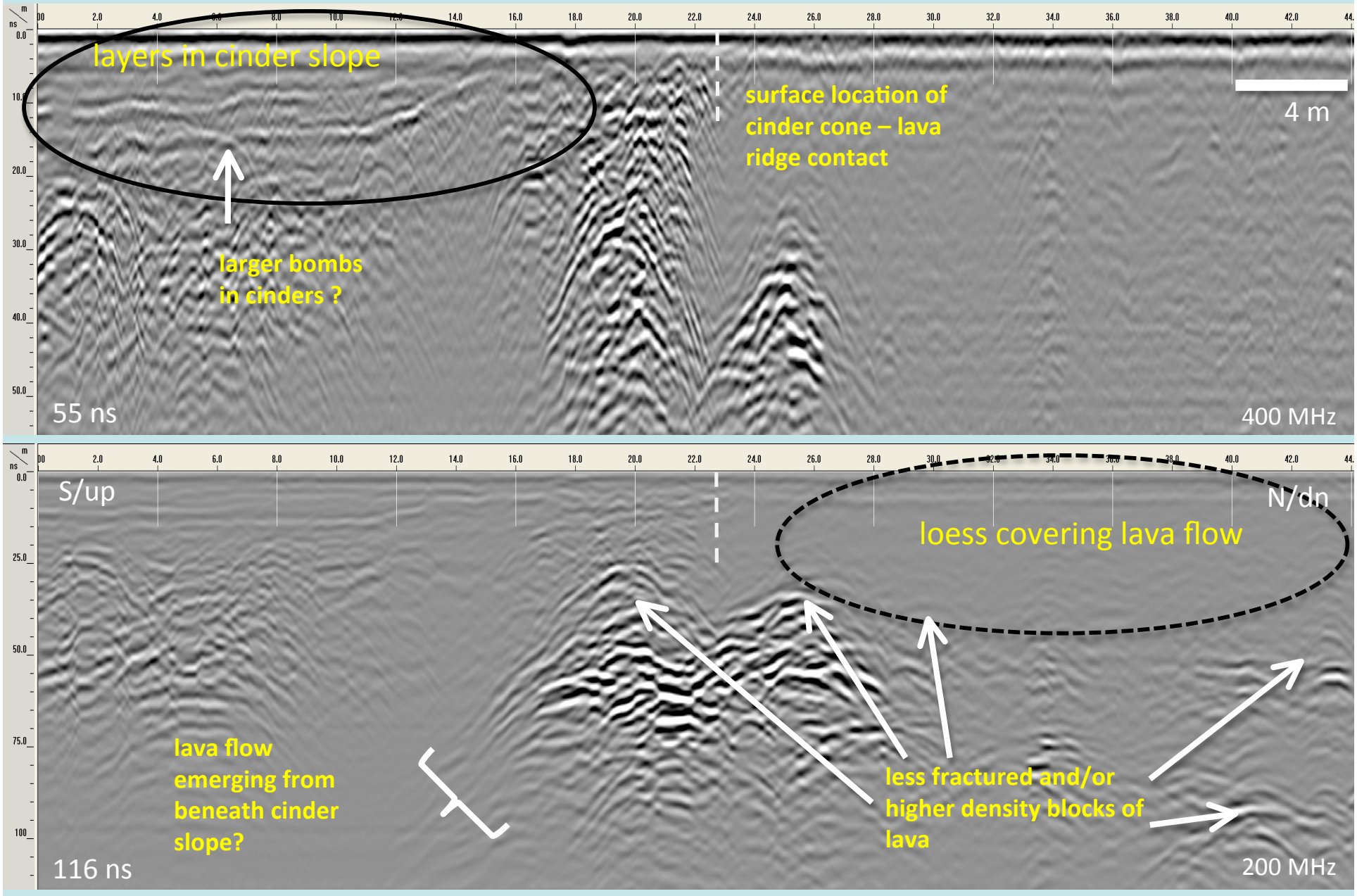


1 m ~ 20 ns from metal plate calibration.
Both GPR and wall photos reveal ~11 blocks per m^3.
Decrease in number of blocks w depth.
200 MHz sees deeper, but fewer/larger blocks.

SP Cinder Cone & Lava Flow



SP Cinder Cone & Lava Flow



Implications

- GPR can identify useful geologic information in the subsurface.
- Penetration likely greater on Moon.
- Calibration needed to convert to depth.
- Rover deployment: in contact with ground or elevated above.
- Complement orbiting radar.